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Session 4 of the 2016 Drug Design and Delivery Symposium

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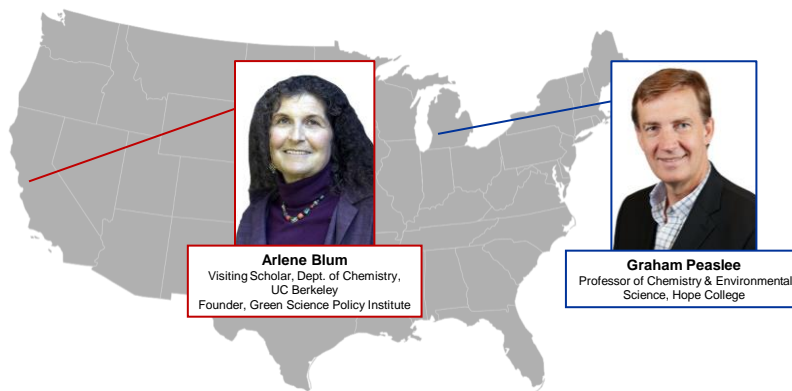
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***“Tackling Toxics: The Chemical Class Approach
Towards Healthier Products and Materials”***



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Tackling Toxics: The Chemical Class Approach towards Healthier Products and Materials

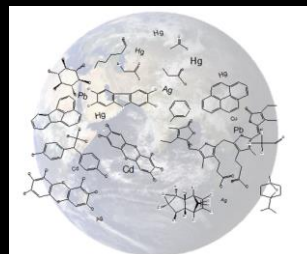
Arlene Blum PhD

Visiting Scholar, Dept. of Chemistry, UC Berkeley
 Founder, Green Science Policy Institute



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A Planetary Boundary for Chemical Pollution



Chemical pollution is global:

- Rapidly increasing global production
- Persistence and long range transport
- Finite capacity of the earth to absorb toxics

Demands a globally coordinated response

Diamond et al, 2015, Environment International



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Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



If a chemical is in your cosmetics, your coat or your couch, who has the authority to make sure it's safe for human health?

- The FDA
- The EPA
- State and local governments
- The World Health Organization
- No one

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PROBLEM

U.S. Toxic Substances Control Act (1976)

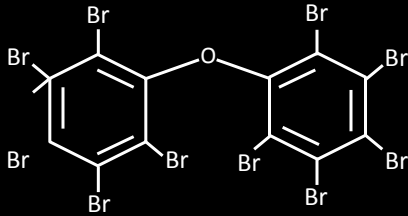
- 62,000 previous chemicals “grandfathered”
- 20,000 new chemicals
 - 85% have no health data
 - 67% have no data at all



Green Chemistry: Cornerstone to a Sustainable California 2008: Cal/EPA



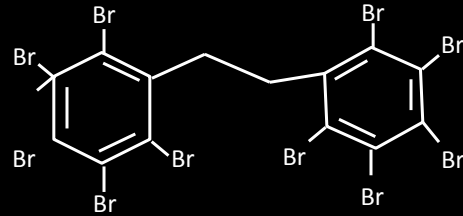
Problem Regrettable Substitution



Decabromodiphenyl
ether

Concerns:

- Persistence
- Bioaccumulation
- Toxicity



Decabromodiphenyl
ethane

Concerns:

- Persistence
- Bioaccumulation
- Toxicity

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PROBLEM Human Toxicological Trial?

“We are conducting a massive clinical toxicological trial, and our children and our children's children are the experimental subjects.”



–Herbert Needleman & Philip Landrigan

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“Tackling Toxics” in *Science*

Scientists can:

- Develop safer chemistries
- Evaluate impacts across lifecycle
- Translate research to catalyze action among users and regulators
- Collaborate on scientific consensus statements
- Contribute to policy recommendations

Purchasers can ask:



“Do we need this chemical, given the potential for harm?”

11 MARCH 2016 • VOL 351 ISSUE 6278
DOI: 10.1126/science.aaf5468



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A Solution: **The Six Classes**

1. **Highly fluorinated chemicals (PFASs)**
stain and water repellants
2. **Chlorinated antimicrobials**
triclosan and triclocarban
3. **Flame retardants**
brominated, chlorinated, phosphate
4. **Bisphenols and phthalates**
phthalates, BPA, BPS, etc.
5. **Organic solvents**
benzene, methylene chloride, xylene, etc.
6. **Certain metals**
lead, mercury, chromium, cadmium, arsenic, etc.



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Is it necessary?

Is it worth it?

Is there a safer alternative?

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Green Chemistry



Courtesy: Dr. Bob Peoples

Green chemistry is the design of chemical products that reduces the use of hazardous substances.

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The Six Classes Challenge

Can the use of the Six Classes in consumer products be reduced by 50% in five years?

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SixClasses.org
15-minute webinars on Six Classes
containing chemicals of concern

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C8 Human Toxicology

PFOS and PFOA persist in the body for years
Health effects linked to exposure to PFOA:

- Kidney and testicular cancer
- Elevated cholesterol
- Thyroid disease
- Delayed puberty, decreased fertility (women) and early menopause
- Reduced immune response in children

Courtesy: Dr. Jennifer Field



C8 replaced with > 40 forms of C6



- Persistent, a family trait
- In groundwater, wastewater, & seawater
- Increasing C6 levels in human blood
- Show signs of possible human health harm

Adopted from slide by Dr. Jennifer Field



The Madrid Statement on Highly Fluorinated Chemicals (PFAS)



flickr @ Marc

Documents the scientific consensus:

- potential for harm
- roadmap to prevent further harm

Signed by 230 scientists from 40 countries

2015: Environmental Health Perspectives



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Now In The News



PFASs Highly Fluorinated Chemicals



November 2015:

Scientific Guidance Panel voted unanimously to add entire class of Highly Fluorinated Chemicals (PFASs) to priority list of chemicals.

<http://biomonitoring.ca.gov/sites/default/files/downloads/SGPMeetingSummaryNovember2015.pdf>



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Brands eliminate fluorinated chemicals

 As of January 2013	 As of July 2013	 As of October 2014	 As of January 2015
 By July 2015	 As of August 2014	 By December 2015	 By December 2015
 By December 2015	 By July 2015	 By December 2015	
 By July 2016	 By December 2017	 99% PFAS-free by December 2017	 By July 2016



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Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



What can we do to reduce the use of highly fluorinated chemicals?

- Choose stainless steel and cast iron rather than nonstick cookware
- Avoid water and stain repellent clothing, furniture and other products unless necessary
- Don't eat microwave popcorn
- Tell manufacturers you want products without highly fluorinated chemicals
- All of the above

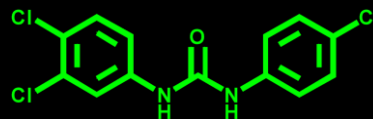
| 33

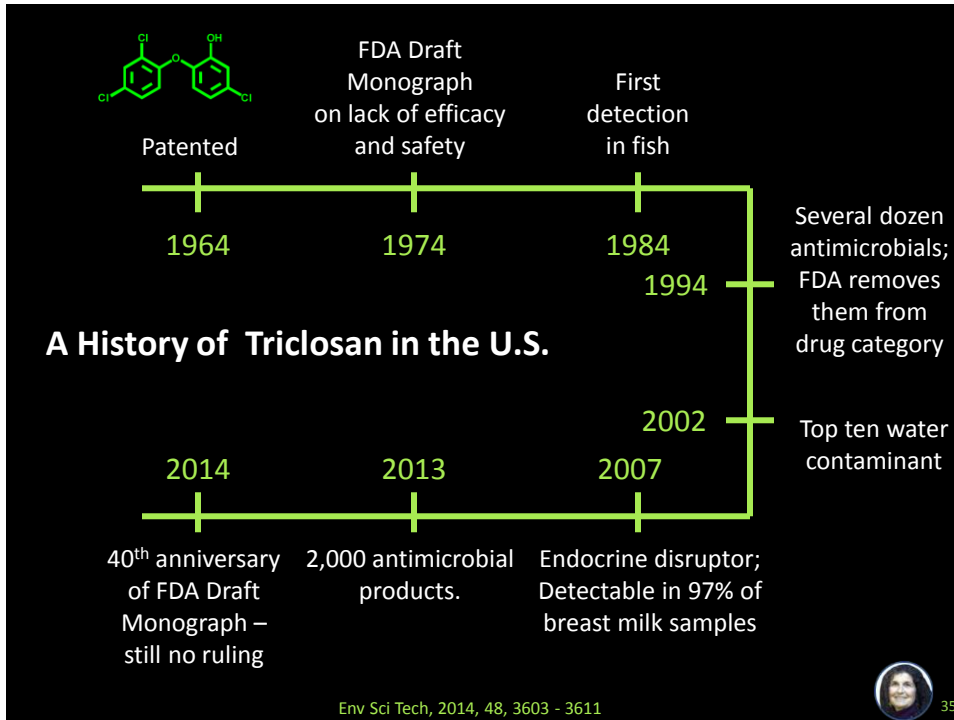
Class 2: Antimicrobials

Triclosan



Triclocarban





Class 3: Flame retardants

1970s Flammability Standards

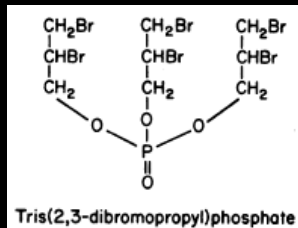
- Children's sleepwear
- Furniture
- Foam plastic building insulation



Brominated Tris Flame Retardant

Tris (2,3-dibromopropyl) phosphate

- In children's sleepwear 1975 to 1977
- Up to 10% of the weight of fabric
- In children's urine
- Mutagen and possible carcinogen



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Science, January 7, 1977

Flame-Retardant Additives as Possible Cancer Hazards

The main flame retardant in children's pajamas is a
mutagen and should not be used.

Arlene Blum and Bruce N. Ames

Green Science Policy Institute
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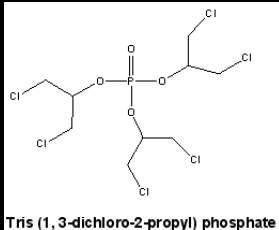


U.S. Consumer Product
Safety Commission

CPSC Bans TRIS-Treated Children's Garments

April 7, 1977

Chlorinated Tris (TDCPP) replaced Brominated Tris



Tris (1,3-dichloro-2-propyl) phosphate

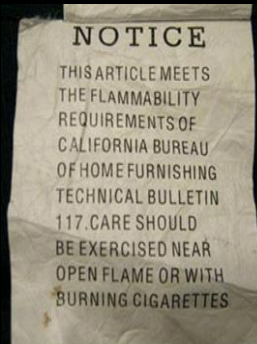
- removed from children's PJ's in 1977
- used today in baby products, furniture

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Technical Bulletin 117



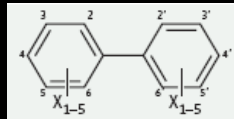
- Required furniture foam to withstand a small open flame for 12 seconds
- No significant fire safety benefit (fires start in exterior fabric not filling)

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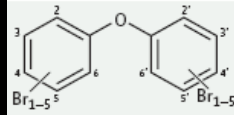


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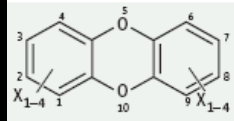
PentaBDE Flame Retardant



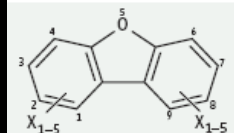
PCBs (X = Cl) and PBBs (X = Br)



PBDEs



Dioxins (X = Cl or Br)



Furans (X = Cl or Br)

Used from 1975 to 2004
to meet TB117.

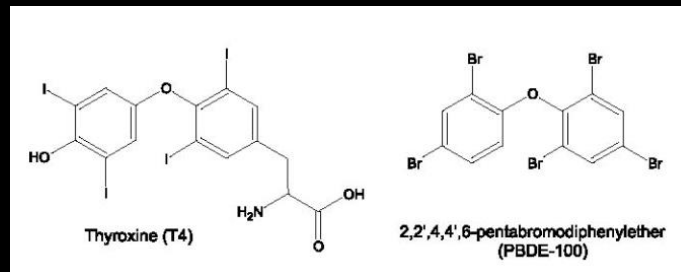
98% of use in US and
Canada in 2003



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Thyroxine

PentaPBDE



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Human Health

Higher pentaBDE

associated with

lower birth weight
impaired attention
poorer coordination
lowered IQ



longer time to get pregnant
altered thyroid hormones



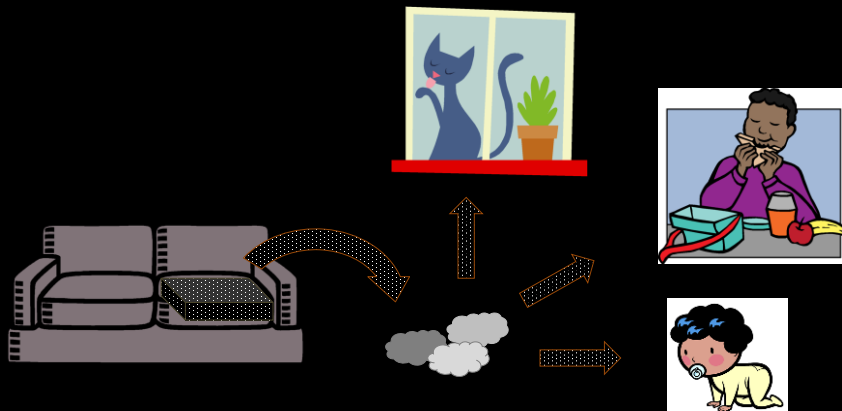
Eskenazi et al, 2010, 2011, 2012

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From Products to People



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TB117 Fire Safety Benefit?

TB117 foam



~

Non - TB117 foam



“No significant, consistent difference...”

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⁴⁵
Babrauskas et al. 2011; Talley 1995; Mehta (CPSC) 2012

San Antonio Statement on Brominated and Chlorinated Flame Retardants

- Signed by over 200 scientist's from 30 countries
- Documents health and environmental harm and lack of proven fire safety benefit



2010: Environmental Health Perspectives

Top Science Paper of 2011

Environmental Science & Technology | 382 | vol 9 | 4/5/011 | 16:11 | Mic: es-2011-007462 | TED: ab00 | BATID: 00000 | Pages: 8-52

ENVIRONMENTAL
Science & Technology

ARTICLE

pubs.acs.org/est

1 Identification of Flame Retardants in Polyurethane Foam Collected 2 from Baby Products

3 Heather M. Stapleton,^{*,†} Susan Klosterhaus,[†] Alex Keller,[†] P. Lee Ferguson,[†] Saskia van Bergen,[§]
4 Ellen Cooper,[†] Thomas F. Webster,^{||} and Arlene Blum[‡]

5 ^{*}Nicholas School of the Environment, Duke University, Durham, North Carolina, United States

6 [†]San Francisco Estuary Institute, Oakland, California, United States

7 [§]East Bay Municipal Utility District, Oakland, California, United States

8 ^{||}Department of Environmental Health, Boston University School of Public Health, Boston, Massachusetts, United States

9 [‡]Department of Chemistry, University of California, and Green Science Policy Institute, Berkeley, California, United States

10 **S** Supporting Information



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Pulitzer Prize
Finalist

Goldsmith Prize
Investigative Reporting

Environmental
Journalists Society
Environmental Reporting

Gerald Loeb Award
Business and Financial Journalism

National Press Club
Consumer Award



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TRIBUNE WATCHDOG

Playing with fire

A deceptive campaign by industry brought toxic flame retardants into our homes and into our bodies. And the chemicals don't even work as promised.



BY PATRICK CALLAHAN AND SAN FEE

David Heinebock knows how to tell a story. In 2008, he described a 3-year-old baby girl who was burned in a fire started by a candle while she lay on a pillow that lacked flame-retardant chemicals.

"That fire is a tiny little person, no bigger than my Italian greyhound at home," said Heinebock, gesturing to approximate the baby's size. "Half of her body was severely burned. She ultimately died after about three weeks of pain and misery in the hospital."

Heinebock's passionate testimony about the baby's death made the long-term health concerns about flame retardants voiced by doctors, environmentalists and even firefighters social abstract and petty.

But there was a problem with his testimony. It wasn't true. Records show there was no doghouse pillow or candle fire. The baby he described didn't exist.

Neither did the 9-year-old patient who Heinebock told California legislators died in a candle fire in 2008. She did die—a 9-year-old patient who he told Alaska lawmakers was fatally burned in her crib in 2009.

Heinebock is not just a prominent baby doctor. He is a star witness for the manufacturers of flame retardants.

His testimony, the Tribune found, is part of a decades-long campaign of deception that has led to the flammable and otherwise

toxic in American homes with pounds of toxic chemicals linked to cancer, neurological deficits, developmental problems and impaired fertility.

The battle started with Big Tobacco, which wanted to shield itself from litigation in the case of fire deaths and continued as chemical companies worked to preserve lucrative markets for their products, according to a Tribune review of thousands of government, scientific and internal industry

records. Heinebock knew that more flame retardants escape from household products and into the air than he had admitted in his story. That's why he didn't mention the fire and didn't mention the higher levels of those chemicals in their bodies than their parents.

Today, scientists know that more flame retardants escape from household products and into the air than he had admitted in his story. That's why he didn't mention the fire and didn't mention the higher levels of those chemicals in their bodies than their parents.

High levels of certain widely used flame retardants, chemical babies in cancer, neurological deficits, developmental problems and impaired fertility.

Recent studies show levels have increased in the US, even though some of the chemicals have been pulled from the market. A typical American baby is born with the highest recorded concentrations of flame retardants among infants in the world.

People might be willing to accept the health risks if the



June 18, 2012

Governor Brown Directs State Agencies to Revise Flammability Standards

“ We must find better ways to meet fire safety standards by reducing and eliminating - wherever possible - dangerous chemicals.”

Press release, CA Office of Gov. Edmund G. Brown, Jr.

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California Flammability Standard TB117-2013

Mandatory January 1, 2015

**Flame retardants not needed,
but can still be used**

Product Labels Required

NOTICE

THIS ARTICLE MEETS THE FLAMMABILITY REQUIREMENTS OF CALIFORNIA BUREAU OF ELECTRONIC AND APPLIANCE REPAIR, HOME FURNISHINGS AND THERMAL INSULATION TECHNICAL BULLETIN 117-2013. CARE SHOULD BE EXERCISED NEAR OPEN FLAME OR WITH BURNING CIGARETTES.

The upholstery materials in this product:
 contain added flame retardant chemicals
 contain NO added flame retardant chemicals

The State of California has updated the flammability standard and determined the fire safety requirements for this product can be met without adding flame retardant chemicals. The State has identified many flame retardant chemicals as being known to, or strongly suspected of, adversely impacting human health or development.

www.bearhfti.ca.gov/about_us/sb_1019_fa.pdf

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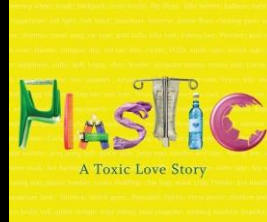


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Class 4: Bisphenols and Phthalates

Uses:

- **Bisphenols:** plastics, cash register receipts, adhesives, can linings
- **Phthalates:** plasticizers, lubricants, solvents, emulsifiers, fragrances



http://www.susanfreinkel.com/books_Plastic.html



Courtesy: Dr. Miriam Diamond



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Class 5: Organic Solvents (aliphatic, aromatic, halogenated, oxygenated)

- **Hydrocarbon solvents**
 - Aliphatic organic solvents (petroleum-based)
 - Aromatic organic solvents (toluene, xylene, benzene)
- **Chlorinated solvents**
 - E.g., Methylene chloride, perc, TCE
- **Oxygenated solvents**
 - Acetone, glycol ethers, alcohols



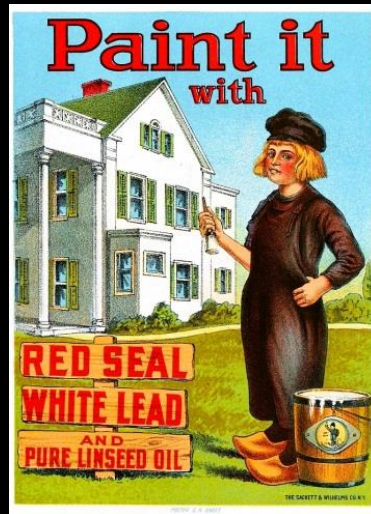
Courtesy: Dr. Liz Harriman



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Class 6: Certain Metals

(arsenic, cadmium, chromium, lead, mercury etc.)



Courtesy: Dr. Graham Peaslee



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The Six Classes Challenge

Can the use of the Six Classes in consumer products be reduced by 50% in five years?



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Buyer's Club



- Require transparency from manufacturers
- Utilize collective purchasing power to create a demand for healthy products and materials

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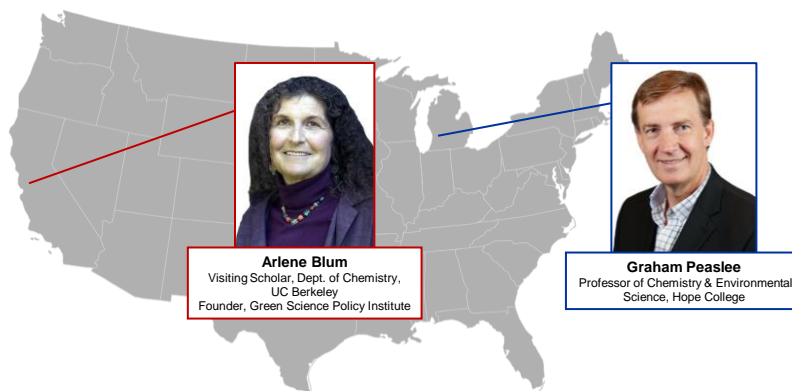


To Learn More:

- [Planetary Boundaries](#)
- [Flame Retardants in Baby Products](#)
- [Flame Retardants in Furniture](#)
- [San Antonio Statement in EHP](#)
- NY Times Magazine on [Flame Retardants in furniture & PFASs](#)
- [Playing with Fire](#)
- [Madrid Statement](#)
- [Science article](#)
- www.sixclasses.org
- www.greensciencepolicy.org



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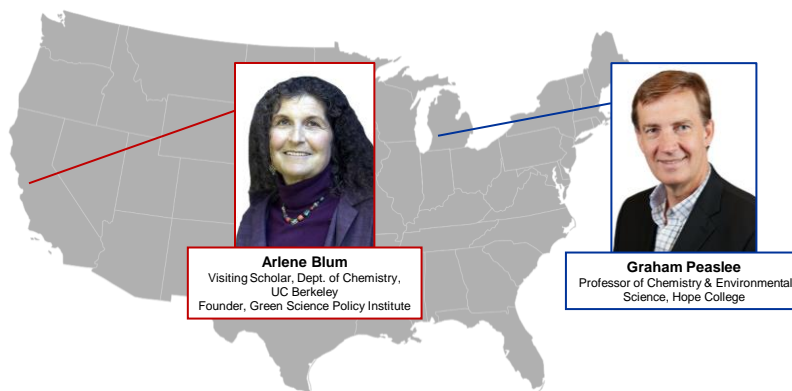
Mark Jones, Executive External Strategy and Communications Fellow, Dow Chemical

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